A6.6 Modelling Methodology

Background Concentrations

A6.6.1 The background concentrations across the study area have been defined using the national pollution maps published by Defra (2015b). These cover the whole country on a 1x1 km grid and are published for each year from 2011 until 2030. The maps include the influence of emissions from a range of different sources; one of which is road traffic. As noted in Chapter 6, there is evidence that the current 'official' emissions factors published by Defra may over-predicted the rate at which road traffic emissions of nitrogen oxides will fall in the future. The maps currently in use were verified against measurements made during 2011 at a large number of automatic monitoring stations and so there can be reasonable confidence that the maps are representative of conditions during 2011. Similarly, there is reasonable confidence that the reductions which Defra predicts from other sectors (e.g. rail) will be achieved.

A6.6.2 In order to calculate background nitrogen dioxide and nitrogen oxides concentrations in 2014, it is assumed that there was no reduction in the road traffic component of backgrounds between 2011[1] and 2014. This has been done using the source-specific background nitrogen oxides maps provided by Defra (2015b). For each grid square, the road traffic component has been held constant at 2011 levels, while 2014 values have been taken for the other components. Nitrogen dioxide concentrations have then been calculated using the background nitrogen dioxide calculator which Defra (2015b) publishes to accompany the maps. The result is a set of 'adjusted 2014 background' concentrations.

A6.6.3 As an additional step, the 'adjusted 2014 background' mapped nitrogen dioxide values have been plotted against national background measurements made as part of the AURN (Defra, 2015d) during 2014 (see Figure A6.6.1). Based on the 40 sites with more than 75% data capture for 2014, the maps show an almost 1:1 relationship, being just 0.2% different. Thus no further adjustment has been applied to the 'adjusted' 2014 background concentrations and 2016, 2018 and 2021 background concentrations. The backgrounds have been derived for each 1x1 km grid point across the study area and then interpolated to each receptor location for use within the modelling.

[1] This approach assumes that there has been no reduction in emissions per vehicle, but that traffic volumes have remained constant. This is not the same as the assumption made for dispersion modelling, in which emissions per vehicle are held constant while traffic volumes are assumed to change year on year. This discrepancy is unlikely to influence the overall conclusions of the assessment.

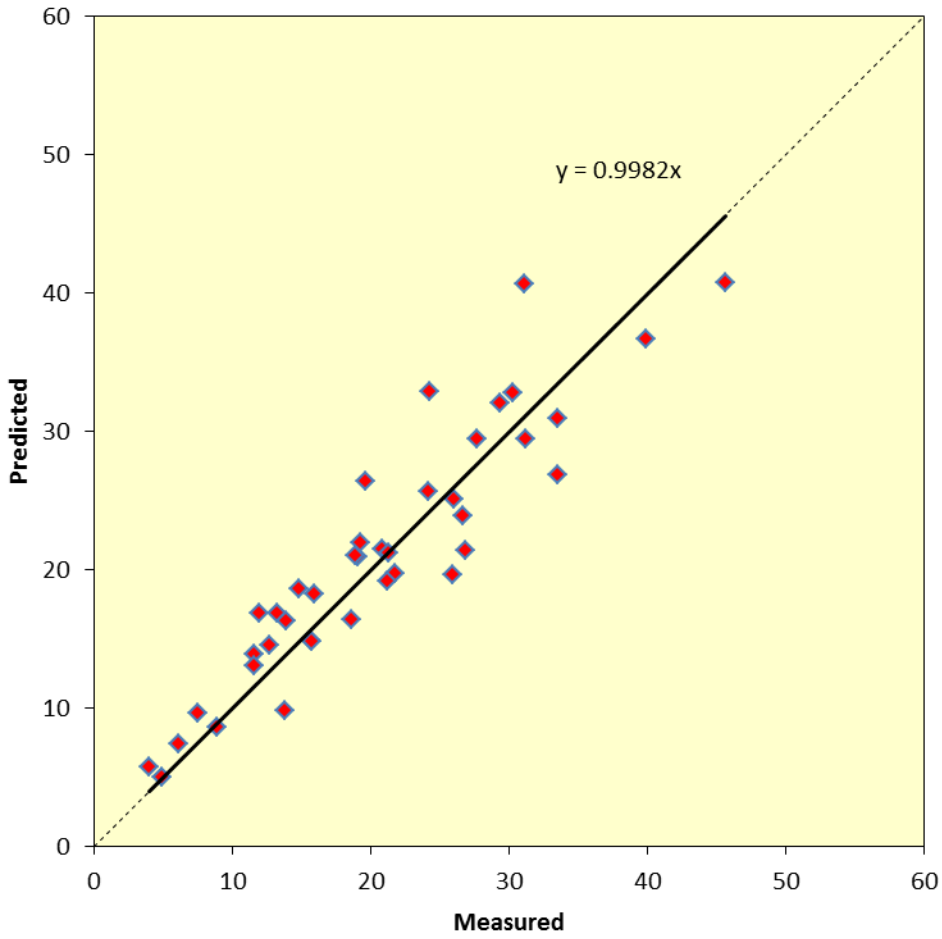

Figure A6.6.1: Predicted Mapped versus Measured NO_2 Concentrations at AURN Background Sites in 2014

A6.6.4 Two separate sets of 2016, 2018 and 2021 background nitrogen dioxide concentrations have been used for the future-year assessment. The 2016, 2018 and 2021 background 'without emissions reduction' has been calculated using the same approach as described for the 2014 data: the road traffic component of background nitrogen oxides has been held constant at 2011 values, while 2016, 2018 and 2021 values for the other components are used as set out in the background maps. Nitrogen dioxide has then been calculated using Defra's background nitrogen dioxide calculator. The 2016, 2018 and 2021 background 'with emissions reduction' assumes that Defra's revised predicted reductions occur from 2014 onward. This dataset has been derived first by calculating the ratio of the unadjusted mapped value for 2016, 2018 and 2021 to the unadjusted mapped value for 2014. This ratio has then been applied to the adjusted 2014 value (as derived in Paragraph A6.6.2).

A6.6.5 For PM_{10} and $PM_{2.5}$, there is no strong evidence that Defra's predictions are unrealistic and so the year-specific mapped concentrations have been used in this assessment.

Model Inputs

Road Traffic

A6.6.6 Predictions have been carried out using the ADMS-Roads dispersion model (v3.4). The model requires the user to provide various input data, including emissions from each section of road, and the road characteristics (including road width and street canyon height, where applicable). Vehicle emissions have been calculated based on vehicle flow, composition and speed data using the Emission Factor Toolkit (Version 6.0.2) published by Defra (2015b). For nitrogen dioxide, future-year concentrations have been predicted once using year-specific emission factors from the EFT, and once using emission factors for 2014[2], which is the year for which the model has been verified.

A6.6.7 The model has been run using the full year of meteorological data that corresponds to the most recent set of nitrogen dioxide monitoring data (2014). The meteorological data has been taken from the monitoring station located at Northolt, which is considered suitable for this area.

A6.6.8 For the purposes of modelling, it has been assumed that certain roads surrounding the development will have street canyon like features, meaning that the model assumes that only limited dispersion occurs within these areas. The roads that have been assumed to be street canyons are shown in Figure A6.5.2. These roads have a number of canyon-like features, which reduce dispersion of traffic emissions, and can therefore lead to concentrations of pollutants being higher here than they would be in areas with greater dispersion. They are not, however, all full canyons, as there are gaps between buildings allowing a reasonable level of near-road dispersion. ADMS-roads may therefore have over predicted concentrations at the façade of the properties adjacent to those streets assumed to be street canyons.

A6.6.9 AADT flows, diurnal flow profiles, speeds, and vehicle fleet composition data have been provided by *Tim Spencer and Co* who prepared the Transport Assessment. Traffic data have been provided for all the scenarios. Baseline traffic data have been derived from 24hr counts at 20 locations within the local area in 2015. These traffic counts were taken on a non-event day and therefore do not include the contribution to the annual average daily flows of the event-day traffic. The one day traffic counts have been adjusted to represent annual average daily traffic (AADT) flows using DfT adjustment factors for typical urban areas, taking account of the time of year the counts were carried out.

A6.6.10 An event-day cordon analysis has been carried out by Tim Spencer and Co. This analysis compared the number of trips that arrived/departed an area of within approximately 1 km of the development per year. This has been based on the number of trips per event multiplied

[2] i.e. combining current-year emission factors with future-year traffic data.

by the frequency of events. This annual trip generation has been compared with the total number of trips predicted on the main local roads for non-event days within 1 km of development (39,154,158 trips) to calculate the ratio of event related traffic to non-event related traffic as an annual factor. Based on 30 events this factor is 1.066 assuming a trip rate per event of 8,550 (30 x 8,550 / 39,154,158). This is assumed to be the existing situation given 30 events per year. The proposed development is predicted to attract fewer trips per event of 6,019, however, the frequency of events is greater at 46 per year, and thus an event day factor of 1.071 has been calculated (46 x 9.019 / 39,154,158).

A6.6.11 The uplift factor of 1.066 has been applied to the baseline 2015 traffic flows. The resultant baseline traffic data set represents AADT flows including the stadium related event-day traffic.

A6.6.12 Tim Spencer and Co have identified that traffic flows on local roads have been fairly constant over recent years, and if anything reducing. Therefore as a worst-case this 2015 baseline traffic dataset has been taken to represent both 2014 and future year baseline traffic data.

A6.6.13 The 2018 “with development” traffic datasets include the traffic generated by the aspects of the development operational in 2018 (36.7% of the full development traffic) and also a contribution to the annual average daily traffic flow of the additional event-day traffic (an uplift factor of 1.071 has been applied to the 2015 baseline traffic rather than 1.066 to account for this). The additional event-day traffic is based on an assumed number of events of 30 THFC matches, 10 NFL games and 6 concerts.

A6.6.14 The 2021 “with development” traffic datasets include the traffic generated by the entire proposed development and also a contribution to the annual average daily flow of the event-day traffic (an uplift factor of 1.071 has been applied to the baseline traffic rather than 1.066 to account for this).

A6.6.15 Traffic speeds have been estimated based on professional judgement, taking account of the road layout, speed limits and the proximity to a junction. The traffic data used in this assessment are summarised in Table A6.6.1 to Table A6.6.4.

Table A6.6.1: Summary of Traffic Data used in the Assessment 2014 and 2018 (AADT)

Road Link	2014		Speed (kph)
	AADT	%HDV	
1	21592	7	35
2	21592	7	35
3	21592	7	25
4	17772	8	25
5	18088	8	25
6	18088	7	25
7	18088	7	25
8	18088	7	25
9	17125	8	25
10	17125	8	35
11	17125	8	35
12	17125	8	25
13	16499	11	25
14	16499	11	35
15	16499	11	35
16	11673	6	25
17	11673	6	35
18	14092	3	25
19	14092	3	35
20	1970	2	25
21	1970	2	30
22	12318	4	20
23	12318	4	30
24	12318	4	30
25	14056	5	35
26	14056	5	35
27	18088	8	20
28	12318	4	20
29	18088	7	20
30	6785	7	25

Road Link	2014		Speed (kph)
	AADT	%HDV	
31	6785	7	35
32	1274	2	30
33	1274	2	30
34	1274	2	30
35	1274	2	30
36	7156	5	25
37	7156	5	35
38	7156	5	35
39	7156	5	35
40	21592	7	35
41	14056	5	35
42	672	4	30
43	672	4	30
44	672	4	30
45	287	1	30
46	21592	7	35

Table A6.6.2: Summary of Traffic Data used in the Assessment 2016 (AADT)

Road Link	2016 (Without Scheme)		2016 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
1	21592	7	21633	7	35
2	21592	7	21633	7	35
3	21592	7	21633	7	25
4	17772	8	17813	8	25
5	18088	8	18129	8	25
6	18088	7	18129	7	25
7	18088	7	18129	7	25
8	18088	7	18129	7	25
9	17125	8	17166	9	25
10	17125	8	17125	8	35
11	17125	8	17125	8	35

Road Link	2016 (Without Scheme)		2016 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
12	17125	8	17125	8	25
13	16499	11	16499	11	25
14	16499	11	16499	11	35
15	16499	11	16499	11	35
16	11673	6	11673	6	25
17	11673	6	11673	6	35
18	14092	3	14092	3	25
19	14092	3	14092	3	35
20	1970	2	1970	2	25
21	1970	2	1970	2	30
22	12318	4	12318	4	20
23	12318	4	12318	4	30
24	12318	4	12318	4	30
25	14056	5	14056	5	35
26	14056	5	14056	5	35
27	18088	8	18129	8	20
28	12318	4	12318	4	20
29	18088	7	18129	7	20
30	6785	7	6785	7	25
31	6785	7	6785	7	35
32	1274	2	1274	2	30
33	1274	2	1274	2	30
34	1274	2	1274	2	30
35	1274	2	1274	2	30
36	7156	5	7156	5	25
37	7156	5	7156	5	35
38	7156	5	7156	5	35
39	7156	5	7156	5	35
40	21592	7	21633	7	35
41	14056	5	14056	5	35
42	672	4	672	4	30

Road Link	2016 (Without Scheme)		2016 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
43	672	4	672	4	30
44	672	4	672	4	30
45	287	1	287	1	30

Table A6.6.3: Summary of Traffic Data used in the Assessment 2018 (AADT)

Road Link	2018 (Without Scheme)		2018 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
1	21592	7	21717	7	35
2	21592	7	21717	7	35
3	21592	7	21717	7	25
4	17772	8	17914	8	25
5	18088	8	18286	8	25
6	18088	7	18286	7	25
7	18088	7	18286	7	25
8	18088	7	18286	7	25
9	17125	8	17400	8	25
10	17125	8	17400	8	35
11	17125	8	17400	8	35
12	17125	8	17400	8	25
13	16499	11	16696	11	25
14	16499	11	16696	11	35
15	16499	11	16696	11	35
16	11673	6	11716	6	25
17	11673	6	11716	6	35
18	14092	3	14137	3	25
19	14092	3	14137	3	35
20	1970	2	2326	2	25
21	1970	2	2326	2	30
22	12318	4	12362	4	20
23	12318	4	12362	4	30
24	12318	4	12362	4	30

Road Link	2018 (Without Scheme)		2018 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
25	14056	5	14101	5	35
26	14056	5	14101	5	35
27	18088	8	18286	8	20
28	12318	4	12362	4	20
29	18088	7	18286	7	20
30	6785	7	6807	7	25
31	6785	7	6807	7	35
32	1274	2	1275	2	30
33	1274	2	1275	2	30
34	1274	2	1275	2	30
35	1274	2	1275	2	30
36	7156	5	7179	5	25
37	7156	5	7179	5	35
38	7156	5	7179	5	35
39	7156	5	7179	5	35
40	21592	7	21717	7	35
41	14056	5	14101	5	35
42	672	4	1028	4	30
43	672	4	1028	4	30
44	672	4	850	3	30
45	287	1	287	1	30

Table A6.6.4: Summary of Traffic Data used in the Assessment 2021 (AADT)

Road Link	2021 (Without Scheme)		2021 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
1	21592	7	21948	7	35
2	21592	7	21948	7	35
3	21592	7	21948	7	25
4	17772	8	18183	8	25
5	18088	8	18670	7	25
6	18088	7	18670	7	25

Road Link	2021 (Without Scheme)		2021 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
7	18088	7	18670	7	25
8	18088	7	18670	7	25
9	17125	8	17941	8	25
10	17125	8	17941	8	35
11	17125	8	17941	8	35
12	17125	8	17941	8	25
13	16499	11	17080	11	25
14	16499	11	17080	11	35
15	16499	11	17080	11	35
16	11673	6	11793	6	25
17	11673	6	11793	6	35
18	14092	3	14214	3	25
19	14092	3	14214	3	35
20	1970	2	3047	3	25
21	1970	2	3047	3	30
22	12318	4	12439	4	20
23	12318	4	12439	4	30
24	12318	4	12439	4	30
25	14056	5	14178	5	35
26	14056	5	14178	5	35
27	18088	8	18670	7	20
28	12318	4	12439	4	20
29	18088	7	18670	7	20
30	6785	7	6845	7	25
31	6785	7	6845	7	35
32	1274	2	1275	2	30
33	1274	2	1275	2	30
34	1274	2	1275	2	30
35	1274	2	1275	2	30
36	7156	5	7217	5	25
37	7156	5	7217	5	35

Road Link	2021 (Without Scheme)		2021 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
38	7156	5	7217	5	35
39	7156	5	7217	5	35
40	21592	7	21948	7	35
41	14056	5	14178	5	35
42	672	4	1749	4	30
43	672	4	1392	3	30
44	672	4	870	3	30
45	287	1	287	1	30

A6.6.16 Diurnal flow profiles for the traffic have been derived from the national diurnal profiles published by DfT (DfT, 2015).

A6.6.17 Figure A6.6.2 shows the road network included within the model, which roads have been assumed to be street canyons and defines the study area.

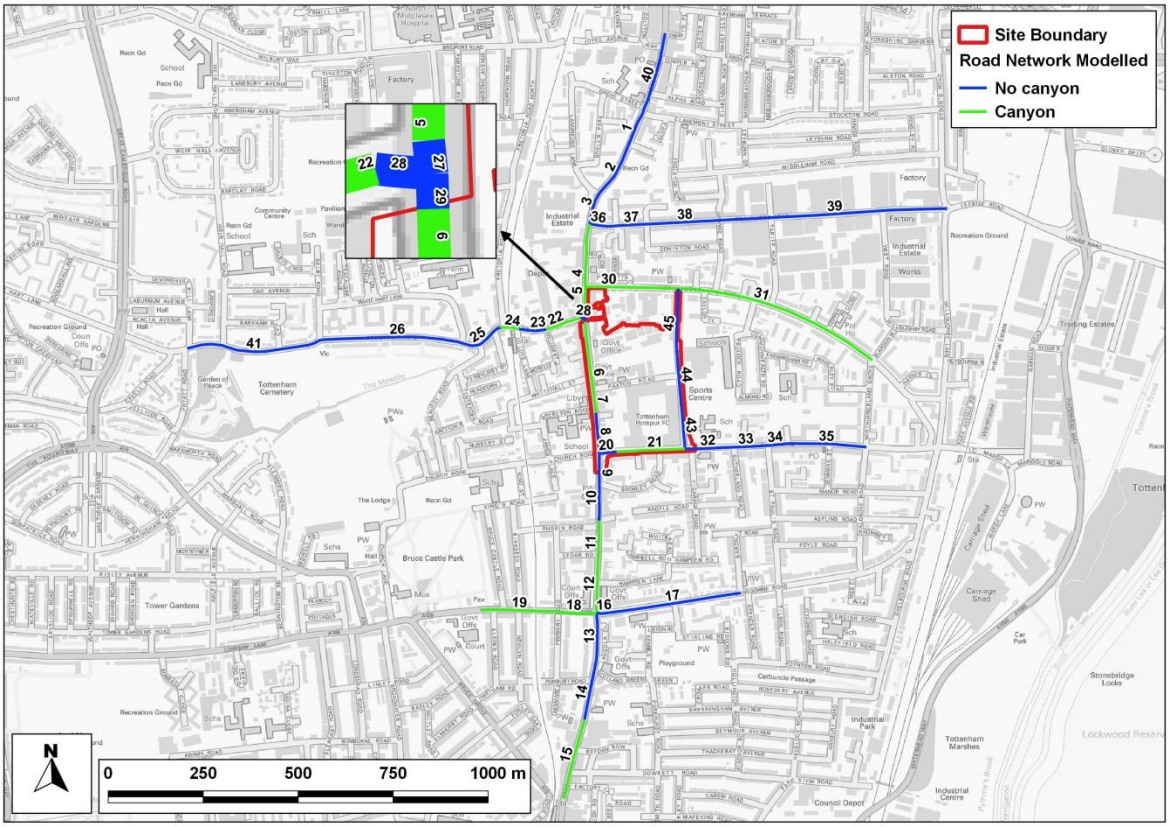

Figure A6.6.2: Modelled Road Network

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Car Parks

A6.6.18 The 'with' development 2021 scenario includes car parks within the development. Vehicles using these car parks may give rise to emission which may impact on the nearby receptors. Emissions from vehicles using the car parks are extracted from the car parks through a number of vents. Most of these have been entered into the ADMS-Roads model as area sources covering the area of the vents through which the emissions are discharged. The vent for the residential car park has been assumed to be located on the façade of Tower A and has been entered into the ADMS-Roads model as a volume source. Emissions from the car parks have also been assumed to flow out of the car park entrances/exits, to provide a worst-case scenario. These have been entered into the ADMS-Roads model as volume sources. The emissions of NOx, PM_{10} and $PM_{2.5}$ have been calculated assuming that all vehicles which use the car park will drive an average distance within the car park at a speed of 5kph, which is the speed associated with maximum emissions and is thus worst-case. The average distance is calculated as the average between the length of the shortest route and the longest route. These emissions have been further augmented to account for the fact that vehicles with cold engines tend to emit more than vehicles with warm engines. The assumption has been made that all vehicles leaving the car park will have cold engines. The cold-start 'penalty' has been calculated from the EXEMPT model[3]. This penalty has been added to the emissions from the car park average route source and applied to the entire length of all the car park routes. Table A6.6.5 shows the emission rates and distances assumed. Figure A6.6.3 shows the modelled area and volume sources.

[3] Defra. (2009). Available via the Air Quality Archive at http://www.airquality.co.uk.

Table A6.6.5: Summary of Car Park Emissions

Parameter	Car Park Source									
	1	2	3	4	5	6	7	8	9	10
Source Type	Area	Area	Volume	Area	Area	Area	Area	Volume	Volume	Volume
Associated Car Park	Basement	Basement	Residential	Ground Floor	Ground Floor	Ground Floor	Ground Floor	Basement	Ground Floor	Residential
Average Loop length (m)	572	572	338	313	313	313	313	572	313	338
AADT	539	539	394	258	258	258	258	539	258	394
Height (m) [a]	25	25	9.8	4	4	4	4	1.5	1.5	1.5
Area (m^2) [b]	8.15	8.92	6.40	7.66	7.85	8.08	8.81	20.8	31.50	20.70
Velocity (m/s) [b c]	5.52	5.05	5.11	3.33	3.33	3.33	3.33	1.00	1.00	1.00
No Reduction [b d]										
NOx (µg/s/m^2)	137.12	125.33	22.86	17.71	17.71	17.71	17.71	24.83	5.31	22.86
PM_{10} (µg/s/m^2)	6.90	6.31	1.12	0.87	0.87	0.87	0.87	1.25	0.26	1.12
$PM_{2.5}$ (µg/s/m^2)	4.51	4.12	0.74	0.57	0.57	0.57	0.57	0.82	0.17	0.74
With Reduction [b e]										
NOx (µg/s/m^2)	102.66	93.83	17.27	13.39	13.39	13.39	13.39	18.59	4.02	17.27
PM_{10} (µg/s/m^2)	5.99	5.47	1.03	0.75	0.75	0.75	0.75	1.08	0.23	1.03
$PM_{2.5}$ (µg/s/m^2)	3.60	3.29	0.59	0.46	0.46	0.46	0.46	0.65	0.14	0.59

[a] For volume sources the height given is the mid-height of the volume source above ground.

[b] The model is constrained by certain density criteria of emissions from sources, such that the areas of sources 4, 5, 6 and 7 had to be adjusted for the model to run. As a consequence of this, the velocities and pollutant emissions rates for these sources were adjusted to correct take this into account.

[c] The velocity of emissions blowing out of the car park entrances/exits is currently unknown. The model is constrained to use a velocity of at least 1 m/s, so as a worst-case assumption this velocity has been used for sources 8, 9 and 10.

[d] This assumes that road vehicle emission factors in 2021 and 2014 remain the same as in 2011.

[e] This assumes that road vehicle emission factors reduce between 2014 and 2021 at the current 'official' rates.

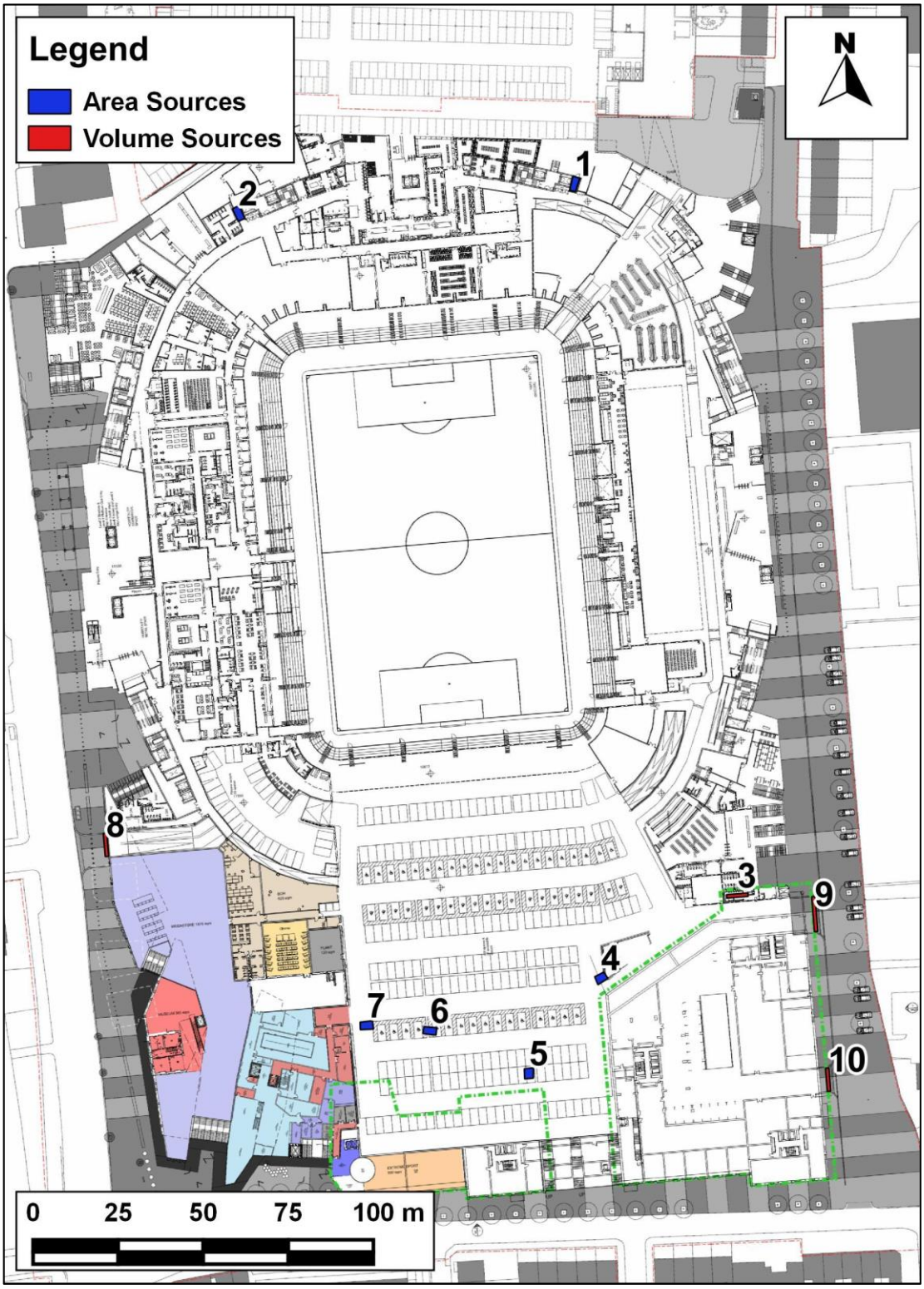

Figure A6.6.3: Development Car Park Modelled Sources

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Point Sources

A6.6.19 The impacts of emissions from the proposed boiler and generator plant have been predicted using the ADMS-5 dispersion model. ADMS-5 is a new generation model that incorporates a state-of-the art understanding of the dispersion processes within the atmospheric boundary layer. The model has been run to predict the hourly contribution of the proposed boiler and generator plant emissions to concentrations of nitrogen dioxide and PM (assumed to be both $PM_{2.5}$ and PM_{10}).

A6.6.20 A summary of the approach involved:

- Met sensitivity testing to establish worst-case met year running the model for long term outputs without chemistry;
- running the model for PM and using chemistry for nitrogen dioxide both with and without the building downwash effect to get the worst-case short term contributions (hour-by-hour) for each receptors for each of the following:
  - The existing UTC and Sainsbury's boiler plant;
  - The onsite development related boiler plant;
  - The stadium related generator plant; and
  - The hotel and residential related generator plant;
- processing the nitrogen dioxide and PM model outputs to calculate realistic worst-case annual mean concentrations based on the operational hours of the various boiler and generator plant;
- processing the nitrogen dioxide model outputs to calculate realistic worst-case short term concentrations based on the greatest combined impacts of all the boiler and generator plant;
- running the model for PM, both with and without the building downwash effect to get the worst-case contributions for a range of percentiles the short term outputs; and
- processing the PM model outputs to calculate realistic worst-case short term concentrations based on the greatest combined impacts of all the boiler and generator plant.

Plant

A6.6.21 The development includes a range of boiler and generator plant:

- The stadium houses 5.6MW[4] of boiler plant and 5000kVA5 of generator plant.

[4] Rated based on Net Thermal Input (net fuel in based on natural gas).

[5] The kVA is the output.

- Residential Tower C houses 4.4MW[4] of boiler plant and 330kVA[5] of generator plant.
- The Hotel house 3.2MW[4] of boiler plant and 0.69MW 330kVA[5] of generator plant.
- The Extreme Sport Building houses 0.56MW[4] of boiler plant.

A6.6.22 The boiler plant will operate on natural gas, while the generator plant will operate on diesel oil.

A6.6.23 The exact plant models are unknown so a number of assumptions have been made to calculate exhaust flow rates based in the fuel consumption and typical operating conditions. These assumptions are shown in Table A6.6.6 and Table A6.6.7. If the real operating parameters are greater than 5% from the assumed values then the modelling may over or under predict the impacts. The emission parameters have been modelled at the threshold limits rather than based on emission rates for specific plant which may not be used in the development. For boiler plant this is 40 mg/kWh and for the generator plant the emission limits for Stage IIIA plant have been used.

A6.6.24 The emissions from the two stadium boiler flues and the two stadium generator flues have been combined in the model into two single flues (one for the boilers and one for the generators) for the purpose of modelling; the emissions parameters employed in the modelling are displayed in Table A6.6.8 and Table A6.6.9.

A6.6.25 The following assumptions have been made:

- The stadium generator plant will operate for 8 hours for 30 days a year (240 hours per annum) on event days to supplement the power required on event days. In addition to this the will be a maximum of 1 hour of maintenance of the plant a week (52 hours per annum). Therefore the stadium generators have been assumed to operation for a worst-case of 292 hours per year;
- The hotel and residential generator plant are backup emergency power generators and will undergo be a maximum of 1 hour of maintenance of the plant a week (52 hours per annum). Therefore the generators have been assumed to operation for a worst-case of 52 hours per year; and
- The boiler plant have been assumed to operators 100% of the time as a worst-case approach.

A6.5. Table A6.6.6: Modelled Boiler Plant Assumptions

Parameter	Sainsbury's	UTC	Stadium	Residential	Hotel	Extreme
Based on Model	Remeha 610-860	ECOMAX 150kW	Strebel F550	Hoval Ultragass 1150D	Hoval Ultragas 1700D	Hoval Ultragas 200
Number of units	2	4	10	4	2	3
Net fuel input per unit (kW)	808	154	560	1,100	1,604	188
Gross fuel input per unit (kW)	895	170	620	1,220	1,777	208
Excess air per unit (%)	27	27	27	27.5	34	34
Condensing?	Yes	Yes	Yes	Yes	Yes	Yes

A6.6. Table A6.6.7: Modelled Generator Plant Assumptions

Parameter	Sainsbury's	UTC	Stadium	Residential	Hotel	Extreme
Based on Model	-	-	MTU 16V4000G23	Cummins QSL9 G5	Cummins QSL9 G5	-
Number of units	-	-	2	1	1	-
Max power out kVA	-	-	2,250	330	330	-
Max power out kWm	-	-	1,798	-	-	-
Max power out kWel	-	-	-	264	264	-
Net fuel input per unit (kW)	-	-	10,300	690	690	-

Gross fuel input per unit (kW)	-	-	11,000	736	736	-
Fuel consumption (litres/minute)	-	-	17.0	1.1	1.1	-
Excess air per unit (%)	-	-	10	75	75	-
Exhaust Temp at plant (°C)	-	-	585	560	560	-
Exhaust Temp at release to atmosphere (°C)	-	-	61	80	80	-

A6.7. Table A6.6.8: Modelled Boiler Plant Specifications, Emissions and Release Conditions

Parameter	Sainsbury's	UTC	Stadium	Residential	Hotel	Extreme
X-Coordinate	533955.4	534005.8	534090.6	534068.0	533969.1	533998.5
Y-Coordinate	191450.0	191422.8	191270.9	191104.7	191118.4	191068.8
Height (m)	12.5	12.5	56.3	121.0	90.2	54.2
Actual Exhaust Velocity (Am/s)	6.94	3.84	7.56	7.50	7.60	7.83
Flue Diameter (m)	0.35	0.30	0.64	0.58	0.49	0.20
Flow rate (Am^3/s)	0.67	0.27	2.39	1.95	1.43	0.25
Release Temperature (°C)	57	79	68	62	69	61
NOx Emission Rate (g/s)	0.0298	0.0072	0.0689	0.0541	0.0395	0.0069

A6.8. Table A6.6.9: Modelled Generator Plant Specifications, Emissions and Release Conditions

Parameter	Sainsbury's	UTC	Stadium	Residential	Hotel	Extreme

X-Coordinate	-	-	534072.6	534116.9	533946.1	-
Y-Coordinate	-	-	191345.0	191164.6	191110.5	-
Height (m)	-	-	56.2	121.0	90.2	-
Actual Exhaust Velocity (Am/s)	-	-	31.1	7.7	7.7	-
Flue Diameter (m)	-	-	0.57	0.26	0.26	-
Flow rate (Am3/s)	-	-	7.82	0.39	0.39	-
Release Temperature (°C)	-	-	61	80	80	-
NOx Emission Rate (g/s)	-	-	21.3748	0.7160	0.7160	-
PM Emission Rate (g/s)	-	-	1.2214	0.0409	0.0409	-

Met testing

A6.6.1 The model has been run to predict long term outputs from meteorological data from Northolt's for 2010-2014. The year associated with the greatest impacts was 2011.

A6.6.2 Hourly sequential meteorological data from Northolt's for 2011 have therefore been used in the detailed modelling.

Building downwash testing.

A6.6.3 The building dimensions and flue location have been obtained from drawings provided by the project team. The locations of the flues are shown in Figure A6.6.4.

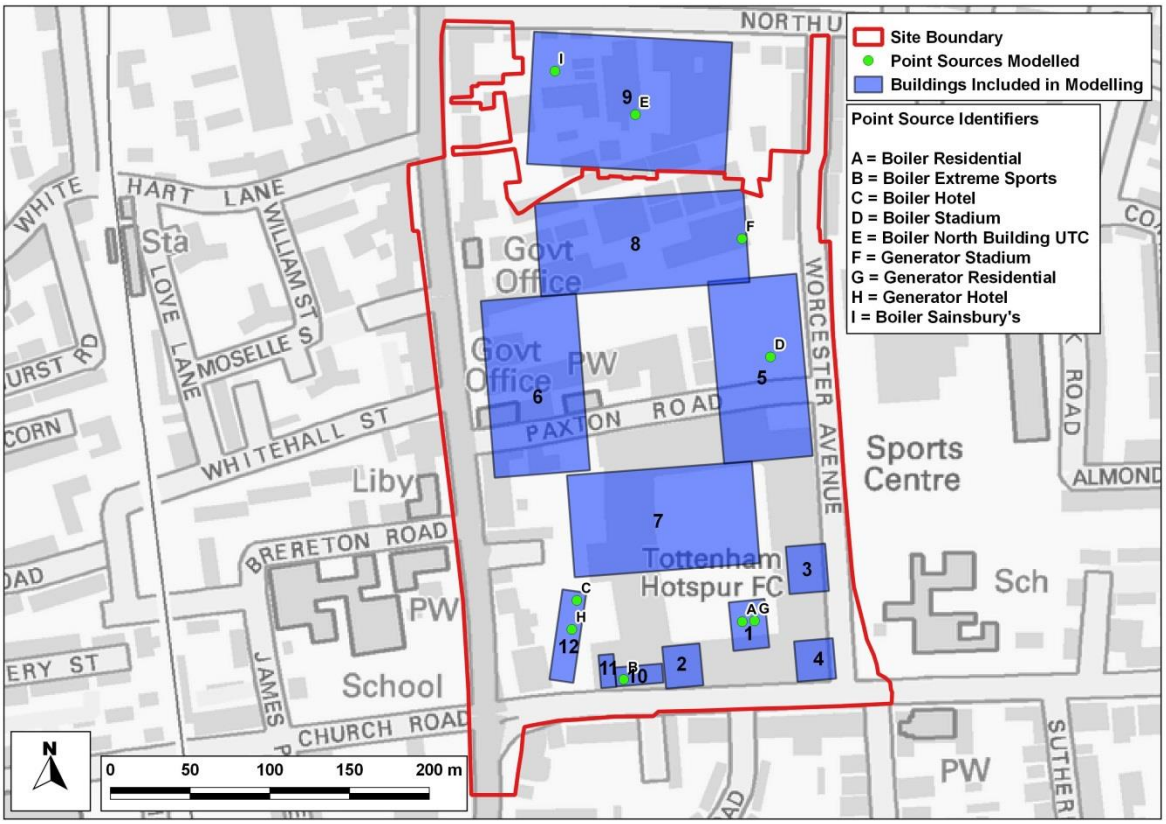

Figure A6.6.4: Flue Location

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A6.6.4 Entrainment of the plume into the wake of the energy centre building (the so-called building downwash effect) has been taken into account in the model. The buildings included in the model are shown in Figure A6.6.4. The model has been run both with and without the buildings included and the worst-case contribution taken for each receptor location.

Chemistry

A6.6.5 The model has been run using the ADMS chemistry module. To take account of the chemistry in the plume, background concentrations of nitrogen oxides, nitrogen dioxide and ozone have been taken from the rural background Lullington Heath AURN site for 2011.

A6.6.6 The calculation of short-term means has been carried out on an hour-by-hour basis. The Lullington Heath data have only been used to inform the chemistry routine, and as such, using a rural site (with relatively high ozone concentrations) provides a worst-case assessment. Where relevant, the process contributions to nitrogen dioxide concentrations derived using this method have been added to local background concentrations (taken either from Defra's background maps). Thus, the use of background data from Lullington Heath should not be taken to imply that the local background concentrations have been underestimated.

Model Verification

A6.6.7 In order to ensure that ADMS-Roads accurately predicts local concentrations, it is necessary to verify the model against local measurements. It is not practical, nor usual, to verify the ADMS-5 model, and, because ADMS-5 does not rely on estimated road-vehicle emission factors, the adjustment used for ADMS-Roads cannot be applied to ADMS-5. Predictions made using ADMS-5 have thus not been verified.

Background Concentrations

A6.6.8 Background concentrations of nitrogen dioxide for the verification sites have been taken from the national maps of background concentrations available from the Defra LAQM Support website (Defra, 2015b). The background concentrations for the verification sites have been calculated using the same methodology as outlined in paragraph A6.4.A6.6.1 to paragraph A6.4.A6.6.3 and are presented in Table A6.6.10.

Table A6.6.10: Background Concentrations used in the Verification for 2014

	NO_2	$PM_{2.5}$
HGY1	29.0	15.0

Nitrogen Dioxide

A6.6.9 Most nitrogen dioxide (NO_2) is produced in the atmosphere by reaction of nitric oxide (NO) with ozone. It is therefore most appropriate to verify the model in terms of primary pollutant emissions of nitrogen oxides (NO_x = NO + NO_2). The model has been run to predict the annual mean NO_x concentrations during 2014 at the Haringey HGY1 automatic monitoring site. Concentrations have been modelled at 3.0 m, the height of the monitor inlet.

A6.6.10 The model output of road-NO_x (i.e. the component of total NO_x coming from road traffic) has been compared with the 'measured' road-NO_x. Measured road-NO_x has been calculated from the measured NO_x concentration and the predicted background NO_x concentration.

A6.6.11 An adjustment factor has been determined as the ratio of the 'measured' road contribution and the model derived road contribution. This factor has then been applied to the modelled road-NO_x concentration for each receptor to provide adjusted modelled road-NO_x concentrations. The total nitrogen dioxide concentrations have then been determined by combining the adjusted modelled road-NO_x concentrations with the predicted background NO_2 concentration within the NO_x to NO_2 calculator (Defra, 2015b).

A6.6.12 The data used to calculate the adjustment factor are provided below:

- Measured NO_2 : 43.82 µg/m^3
- 'Measured' road-NO_x (total – background): 33.99 µg/m^3
- Modelled road-NO_x = 17.94 µg/m^3
- Primary Road-NO_x adjustment factor: = **1.89**[6]
- Final Modelled Total NO_2 (using Defra NO_x:NO_2 calculator) = 44.5 µg/m^3
- Secondary Road NO_2 adjustment factor: 43.82/43.82 = **1.000**

A6.6.13 The factor implies that the unadjusted model is under-predicting the road-NO_x contribution. This is a common experience with this and most other models.

PM_{10} and $PM_{2.5}$

A6.6.14 The model has been run to predict annual mean road-$PM_{2.5}$ concentrations during 2014. A similar process to calculate the road-NO_x adjustment factor has been followed.

A6.6.15 The measured road-$PM_{2.5}$ and modelled road-$PM_{2.5}$ concentrations are compared to provide the factor for $PM_{2.5}$. The data used to calculate the adjustment factor are provided below:

- Measured $PM_{2.5}$: 16.40 µg/m^3
- 'Measured' road-$PM_{2.5}$ (measured – background at monitor): 16.40 – 14.99 = 1.41 µg/m^3
- Modelled road-$PM_{2.5}$ = 0.61 µg/m^3
- Road-$PM_{2.5}$ adjustment factor: 1.41/0.61 = **2.31**

[6] Based on un-rounded values

Model Post-processing

Road Traffic

Nitrogen oxides and nitrogen dioxide

A6.6.16 The model predicts road-NOx concentrations at each receptor location. These concentrations have then been adjusted using the primary adjustment factor, which, along with the background NO_2, has been processed through the NOx to NO_2 calculator available on the Defra LAQM Support website (Defra, 2015b). The traffic mix within the calculator has been set to "All London traffic", which is considered suitable for the study area. The calculator predicts the component of NO_2 based on the adjusted road-NOx and the background NO_2. This has then been adjusted by the secondary adjustment factor to provide the final predicted concentrations.

Short-term PM_{10}

A6.4.4. The number of exceedences of 50 µg/m^3 as a 24-hour mean PM_{10} concentration has been calculated from the adjusted-modelled total annual mean concentration following the relationship advised by (Defra, 2009):

$$A = -18.5 + 0.00145 B^3 + 206/B$$

where A is the number of exceedences of 50 µg/m^3 as a 24-hour mean PM_{10} concentration and B is the annual mean PM_{10} concentration. The relationship is only applied to annual mean concentrations greater than 16.5 µg/m^3. Below this concentration, the number of 24-hour exceedences is assumed to be zero.

Point Sources

Process contributions

A6.6.17 In order to determine the process contributions from the proposed plant, the model has been run several times with the following:

- with just the baseline existing emissions (Sainsbury's and UTC boilers). [Scenario 1];
- with scenario 1 and the development boiler plant. [Scenario 2];
- with scenario 2 and the hotel and residential generator plant. [Scenario 3];
- with scenario 3 and the stadium generator plant. [Scenario 4];

A6.6.18 The process contributions have then been calculated by taking the difference between the scenarios.

Long-term nitrogen dioxide and PM

A6.6.19 In order to calculate the annual mean concentrations the process contribution from each of the following have been calculated and then summed with the annual mean concentration from the combined background, the modelled existing boiler plant in Sainsbury's and UTC, the modelled road traffic and the modelled car parks:

- 292 hours of stadium generator process contributions;
- 52 hours of hotel and residential generator process contributions; and
- annual process contribution from the development boilers.

A6.6.20 The specific hours of the year which the plant will operate and the associated meteorological data are unknown. Therefore the relevant number of hours of operation have been taken for each aspect at random from the entire hour-by-hour annual outputs. These hourly concentrations have been summed to provide the contribution to the annual mean. This process has been repeated 1,000 times to represent 1,000 years of operation and the highest annual mean contribution has been used as the realistic worst-case annual mean process contribution.

Short-term nitrogen dioxide

A6.6.21 In order to predict total 1-hour mean nitrogen dioxide concentrations the following formula has been applied for each location:

99.79^{th} percentile process contribution NO_2 + 2 x annual mean nitrogen dioxide concentration of the combined background, the modelled existing boiler plant in Sainsbury's and UTC, the modelled road traffic and the modelled car parks.

A6.6.22 The difficulty with assessing against the 1-hour objective for nitrogen dioxide is that the hours of the year the generators will be used is unknown, and furthermore, the meteorological conditions within these hours cannot be predicted. To overcome this, a statistical model has been designed and run to simulate 1,000 years of operation, in order to identify the realistic worst-case 99.8^{th} highest 1-hour nitrogen dioxide concentration. The statistical model has been run 1,000 times as this is deemed to be a sufficiently large dataset with which to carry out a robust statistical analysis. Each run take 52 hours at random from the entire year of 1-hour concentrations modelled assuming all the sources within the development are operating simultaneously, which is a worst-case assumption. The 18th highest value is taken to represent the 99.79^{th} percentile. This simulation was repeated 1,000 times to represent 1,000 artificial years of data and the highest value of all 1,000 years has been taken for the assessment.

A6.9. Short-term PM_{10}

A6.6.1 The short-term PM_{10} objective permits 35 exceedences of 50 $\mu g/m^3$ as a daily average concentration per year. The 35th highest day is equivalent to the 90.4th percentile of 24-hour mean concentrations. If this 90.4th percentile is greater than 50 $\mu g/m^3$, then there will be more than 35 days exceeding 50 $\mu g/m^3$ and thus there will be an exceedance of the limit.

A6.6.2 The combined road traffic, car park emissions and background concentrations have been used to calculate a number of days greater than 50 $\mu g/m^3$ due to those sources (see Paragraph **Error! Reference source not found.**). Using these predicted number of days xceeding 50 $\mu g/m^3$ due to road traffic and background sources it is possible to calculate a headroom of number of days before the 35 days limit is reached. This is the number of extra days the point sources could cause exceedences of 50 $\mu g/m^3$ before the 35 day limit is reached. An equivalent percentile for each of these headroom days was calculated and used as a "relevant percentile" of 24-hour means. This approach is worst-case because the days predicted to exceed 50 $\mu g/m^3$ due to the boiler and generator plant may coincide with days on which the 50 $\mu g/m^3$ is already being exceeded and therefore there may be an element of double counting.

A6.6.3 In order to predict the equivalent 90th percentile of 24-hour mean PM_{10} concentrations the "relevant percentile" of 24-hour mean process contribution (for the headroom days) has been added to twice the annual mean PM_{10} concentration of the combined background, the modelled road traffic and the modelled car parks.

A6.6.4 The total predicted concentrations have then been compared to the air quality objectives to determine the significance of any effects with reference to Appendix A6.3.